Chapter 7:

PUTTING WATER WHERE IT IS NEEDED: THE INS AND OUTS OF DRIP IRRIGATION

Drip irrigation was pioneered in Israel many years ago in an effort to grow crops in desert areas with limited water supplies. Now this method of irrigation is used throughout the United States to water row crops, vineyards, orchards and greenhouses. In addition, drip irrigation has found a firm place in the landscape industry for watering ornamental plants and conservation plantings.

Drip irrigation is a method of watering in which water is applied slowly to the root zone of a plant. Water is delivered at low pressure through a tube to a small device called an "emitter" which releases water over an extended time period. This watering avoids waste and guards against runoff and soil erosion.

Why should I use drip irrigation?

Drip systems offer many advantages over irrigation systems that use sprinklers, bubblers and hose-end watering devices. Below, you'll find a list of the benefits and disadvantages of using a drip system. Once installed, drip systems can provide careful application of water to the root zone of the plant, where it will be immediately available to the plant.

What are the main components of a drip system?

The basic components of a system include tubing, most often made of black polyethylene, served from main lines of buried PVC pipe. Water is delivered through emitters that have small openings to deliver water at specific low rates. Other fittings include mini-sprayers, mini-

Benefits	Disadvantages
Slow application of water to the soil and roots with little waste	Requires periodic checking to make sure system is functioning properly
Lower pumping costs and reduced energy needs	Prone to rodent damage
Water large areas with a small amount of water	Dirt can clog emitters
Low water pressure requirements	Emitters may be difficult to locate during inspections
Reduced runoff and pollution of lakes and streams	Weeds may grow near the base of the plants
Reduced weed growth overall	Decreased humidity around plants
Accurate spot watering of plants	May restrict root development if not installed properly
Flexible design uses, including pots, ornamentals, trees, and shrubs	Requires occasional modifications
Can be used to distribute fertilizer	Initial cost is more than some systems
Saves time and labor once system is installed	Requires more maintenance than hose-end systems
Uses low flow rates	
Provides better water distribution on slopes	
Less prone to vandalism	
Water applications are uniform if system is designed and installed correctly	

sprinklers, and soaker tubing. Valves are used to turn the water on and off, and filters remove particles from the incoming water to help avoid clogged emitters. Backflow preventers prevent backsiphoning of contaminants into the supply line. Pressure compensating regulators or emitters are available to maintain correct pressure and flow rates on slopes.

The system can be connected to your main water line or to a hose bib. Because many household lines operate at higher pressures, most drip irrigation systems need a pressure regulator installed between the filter and the main drip line to keep pressures between 20 and 30 pounds per square inch (PSI). A good filter is also recommended to prevent the emitters from clogging, particularly if your water supply is from a well.

What are the different types of drip systems?

The most common drip systems include:

1. Emitters with tubing
2. In-line tubing and pressure-compensating emitters
3. Sweat tubing or porous hose
4. Misters or low volume sprinklers

<u>Emitters with tubing</u>

In these systems, tubing delivers water to the emitter, which then delivers water to the individual plant, as shown at the right. Installation is relatively easy and inexpensive. Drip tubing is manufactured in ½- to ¾-inch diameters. The tubing size depends on the application. For example, ½-inch tubing easily services residential landscapes of less than a third acre. Large landscape projects or commercial projects use ¾-inch tubing. The tubing is usually buried in shallow trenches or laid on top of the soil and covered with mulch after the emitters are in place. Burying the tubing secures it and reduces the potential for damage, but also makes it more difficult to find and repair. Typically, one hundred feet of drip tubing costs $7 to $10, and emitters $0.25 to $1.50 each, depending on the size and supplier.

Fittings such as 90-degree elbows and "T's" are installed by slipping the tube into the fitting. Because of their design, and since the water pressure is low, the fittings stay in place without glue.

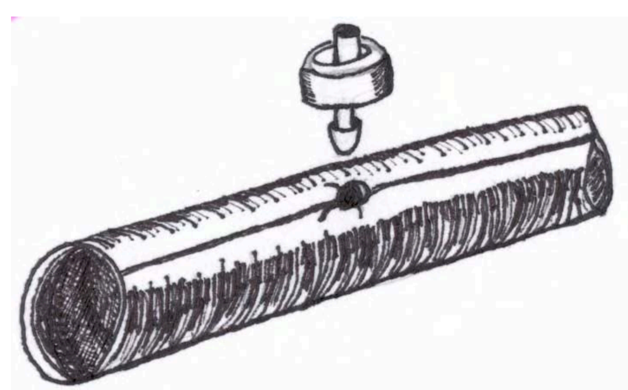
Emitters come in different shapes and sizes and are rated according to operating pressure in pound per square inch (PSI). Emitters are designed to handle low water pressures, i.e. 10, 15, and 20 PSI. Manufacturers color code them according to the amount of water they emit, from ½ to 5 gallons per hour (GPH). Each color indicates a single delivery rate. Typically the smaller the GPH, the smaller the opening, making them more vulnerable to clogging.

Emitters are barbed at one end and are installed by punching a pilot hole in the tube for the emitter. To permit the correct fit for the emitter and eliminate leakage, always use a hole punch specifically designed for drip tubing.

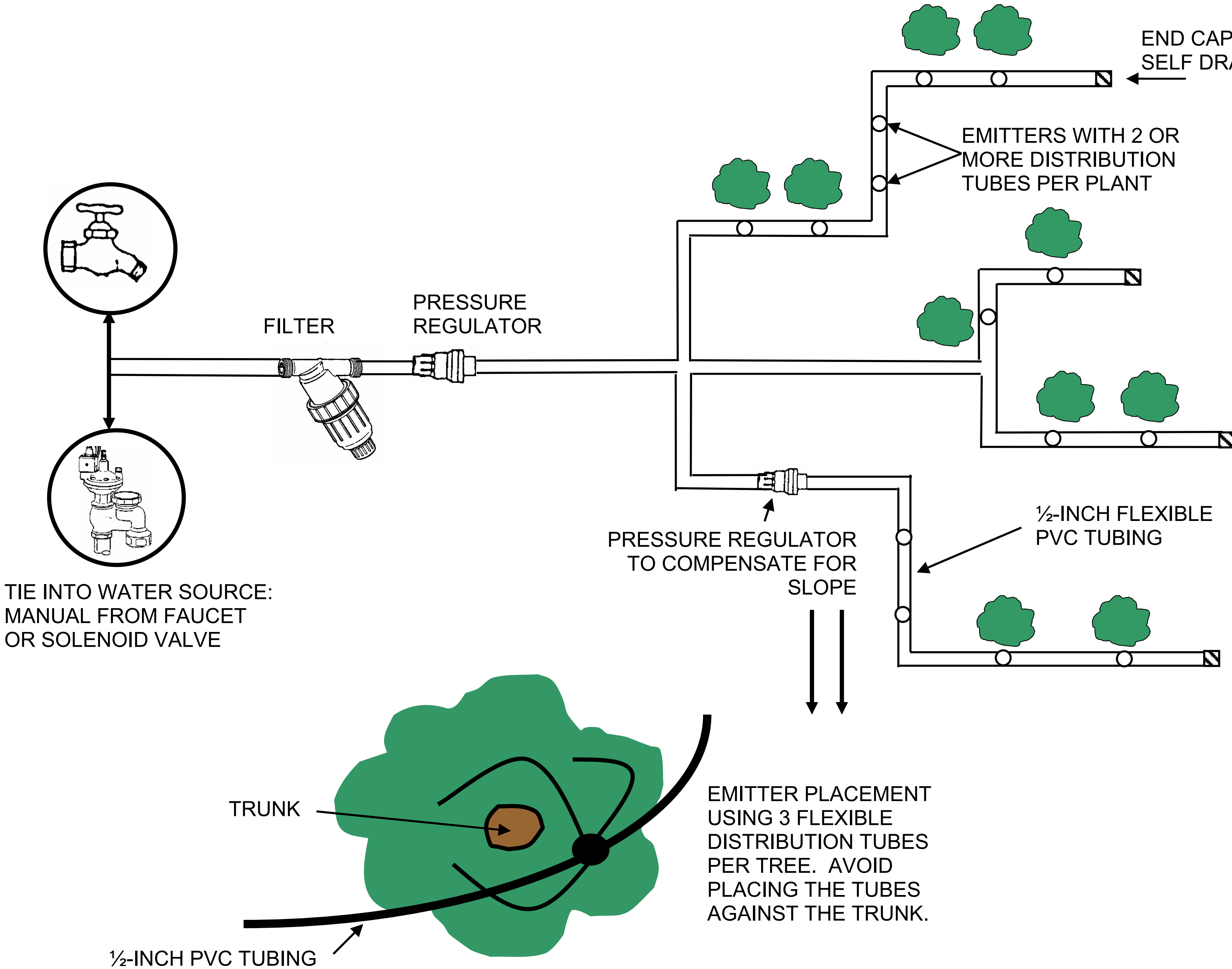
Drip irrigation requires maintenance. During the growing season, monthly inspections of the emitters as well as the soil will ensure the emitters are working and plants are receiving adequate amounts of moisture.

<u>In-line tubing and pressure-compensating emitters</u>

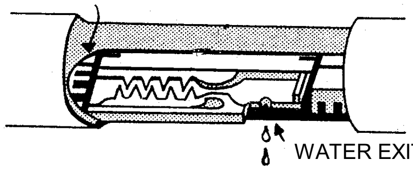
In-line emitters are pre-installed in ¼ inch drip tubing, avoiding the need to punch holes and install the emitters. Emitters are spaced at regular intervals (e.g., one every 12, 18, 24 or 36 inches) to accommodate different planting spaces, and are designed to reduce the chance of clogging. In-line



Drip emitters provide slow, constant flow to the root zones of individual plants.



Elements of a drip system



In-line emitters are spaced at regular intervals and are often used in vegetable gardens where even spacing is critical. The expanded view shows a pressure-compensating in-line emitter. A flexible diaphragm regulates pressure and flushes any particles that might clog the emitter.

emitters are often used in vegetable gardens where spacing is critical, or placed in rings around perennials such as trees and shrubs. They cost more than a conventional tube and emitter system.

Pressure compensating in-line emitters (PCE) (shown above) differ significantly from non-compensating emitters. PCEs have a diaphragm while the others do not. PCEs compensate for variations in pressure due to elevation changes up to 20 feet and provide a steady rate of water flow to the plants while operating under low water pressures fluctuating from 7 to 25 PSI. These emitters are used if your system is on sloping ground with more than a 5-foot elevation change, if your lateral lines are longer than 200 feet, or if the emitters on the line deliver more than 100 GPH. In-line pressure compensating units are also available when regular emitters are used on slopes or runs are long. This may be less expensive than purchasing a complete PCE system.

Although this type of system has advantages over tube and emitter systems, it is not recommended for plants placed far apart because the emitters are pre-installed and spacing cannot be changed. Line layout can also be a problem because the pre-installed emitters tend to make the delivery tube less flexible.

One advantage of both these types of in-line emitters is that they are self-flushing and thus clog less frequently than regular punched-in emitters. Other benefits include easy installation and reduced chance of leaking. Pressure compensating in-line emitters also ensure even distribution of water under fluctuating water pressure and on hilly areas.

Before purchasing one of these systems, contact your local irrigation supply company or hardware store and ask about longevity of the system under local conditions, methods of proper care, and availability of spare parts. Doing so will help you decide if this is the right system for you.

<u>Sweat tubing or porous hose</u>

Sweat tubing or porous hose, also called soaker hose (shown below), is made from used tires or new tire trimmings mixed with polyethylene. The hose waters slowly by weeping moisture into the soil. Since there are thousands of holes, the soil becomes moist beneath the entire length of the hose.

Porous hose made from recycled tires sweats water from tiny pores evenly along the entire length of the hose.

One disadvantage of porous hose systems is that fittings may leak or come apart at high water pressure. To eliminate difficulties associated with high water pressure, install a pressure regulator and adjust it to 10 pounds per square inch (PSI). Also, because the pores are very small, install a 200-mesh filter or “Y” filter to prevent the hose from clogging.

The benefits of using a porous hose are its durability, availability, and ease of installation. It can also be buried and is self-draining to protect it from freezing. These systems are useful for vegetable and flower plantings that are replaced each year.

There are drawbacks to porous hose, however. If left uncovered, a 5/8-inch hose can be unattractive, as are the metal hose clamps used for insert fittings. Also, if unchlorinated water (e.g., well or ditch water) is used and tubing is left above ground, algae can grow inside and clog the internal pores. Gophers have also been known to chew through hoses. Lastly, and most importantly, flow rates can vary considerably from the beginning to the end of the line, resulting in dry spots or unevenly wetted soil. For this reason, the effective length of a soaker hose is limited.

Soil texture can also limit the effectiveness of drip systems. If the soil is sandy, water will tend to move down, rather than horizontally, requiring closer spacing. See Chapter 2 for an explanation of wetting and soil moisture profiles.

When are low volume misters appropriate?

Misters or low-volume sprinklers (shown above) are installed and operate in much the same way as punch-in emitters except they are used above ground. They are often used to water low-growing groundcovers, bedding plants, and potted annuals or used in conjunction with an in-line system to germinate seeds.

Their spray patterns, like pop-up lawn sprinklers, range from a 45-degree angle to a full circle. However, their spray pattern (radius) is much smaller than lawn sprinklers, but covers a greater distance than an emitter system.

Low volume mister systems cover a larger area, producing a larger and healthier plant. The system also offers the homeowner more flexibility than tubes and emitters. Another advantage is that low volume misters can be adjusted easily whereas in-line and tube emitters cannot.

However, as larger areas become wet, more weeds are able to germinate. The system can be more easily broken than other systems, and the cost is greater. Additionally, more gallons of water per minute are needed to operate spray systems, and they require more fittings than conventional drip systems, including various “holders” to keep the mini-spray heads in place as well as couplers, tees, 90 degree barb elbows, and 1/8-inch to ¼-inch “spaghetti tubing. These additional fittings can increase the cost considerably.

What do I need to know before I design my system?

Begin designing your system by assessing the water pressure and availability, if you have a domestic well. Pressure in pounds per square inch (PSI) and water availability in gallons per minute (GPM) will determine the number of valves required to irrigate a specific area, the length of tubing, and the number of emitters that can be placed on a single line. Pressure can be measured using a simple pressure gauge, available at irrigation equipment or hardware stores. Measure

Low-volume misters deliver overhead irrigation in a fine mist from the flexibility of drip tubing.

SIZE WATER METER	SIZE SERVICE LINE	WATER PRESSURE (PSI)							
		30	35	40	45	50	55	60	65
		GALLONS PER MINUTE (GPM) OUTPUT							
5/8”	½”	2.0	3.5	5.0	6.0	6.5	7.0	7.5	8.0
5/8”	¾”	3.5	5.0	7.0	8.0	9.5	10.0	11.0	11.5
¾”	¾”*	5.0	7.0	8.0	9.0	11.0	12.0	14.0	15.0
¾”	1”	7.5	10.0	11.5	13.5	15.0	16.0	17.5	18.5
1”	¾”	6.0	7.5	9.0	10.0	12.0	13.0	15.0	16.0
1”	1”*	9.0	12.0	13.5	17.0	19.0	20.0	21.0	21.0

**Use these values for service lines without water meters*
Table provided by Lawn Genie

the pressure at an outside faucet. First open two faucets inside the house to simulate typical water use. Then open the outside faucet completely and record the pressure shown on the gauge.

You will need to know the size of the service line to calculate the gallons per minute (GPM) output. The simplest way to determine the size of the service line is to check the size stamped on the side of the water meter, if present. Once you have determined the size of the service line and the water pressure, use the table above to determine the GPM for your water-metered system.

If do not have a water meter, but you do have a well pump, it will have a capacity rating in gallons per minute that should be provided in your well pump documents. Alternatively, you can place a five-gallon container under an outdoor faucet, open the faucet completely, and measure the amount of time in seconds needed to fill the bucket. Repeat the test several times. Divide the capacity of the bucket in gallons by the largest amount of time in seconds to calculate gallons per second. Next, multiply the gallons per second by 60 to calculate delivery volume in gallons per minute, as shown in the example on the right. Please note that this method provides only the GPM available through the faucet, which may be less than the flow through the service line. This method is useful only for systems which will attach to the outdoor faucet.

Water use by the sprinkler system should not exceed 75 percent of the available water flow at the faucet or from the pump. This allows for fluctuations in indoor water use.

Next, read Chapter 12 of the Small Ranch Manual and make a landscape plan, noting the plants' locations and where drip systems might be used. Make note of any obstacles between the water source and the part of your landscape to be serviced with the drip system, such as walkways or patios. Also determine any slopes that may limit the components that are used.

Your plants will have different watering requirements, both in terms of quantity and frequency. Group plants with similar water needs on separate drip systems, or use separate control valves for systems connected directly to the household water lines.

Sample Flow Calculation for Wells with No Water Meters

1. Bucket Size: 5 gallons
2. Time to Fill* (maximum) 25 seconds
3. Gallons per Second: 5 ÷ 25 = .2 Gallons per Second
4. Multiply Gallons per Second X 60 = 12 Gallons per Minute (GPM)

**Use the time measured for your system.*

How are main lines installed?

In your design phase, you determined the number of separate systems needed. Lines may be buried 2 to 3 inches below the soil surface, or placed on the surface. Buried lines last longer, are less likely to be damaged, and avoid visual distraction. On the other hand, surface lines are easier to install, find, maintain, and repair. They can be disguised by placing a few inches of mulch over them.

How many emitters can I put on a line?

Theoretically, you can use up to 225 one-gallon-per-hour emitters for each 300 feet of tubing and still have the system function properly. This will vary by manufacturer and site requirements. Since emitters are available in ½ to 5-gallon-per-hour rates, any combination can be used as long as the maximum gallons-per-hour rate is not exceeded. When the limit is exceeded, the flow rate will vary and your system may not deliver water evenly.

Where should emitters be located relative to the individual plants?

Tube systems should be laid out so that emitters can be evenly spaced around and on top of the root ball of newly planted trees and shrubs. Place enough emitters to wet the entire rootball and surrounding soil. This helps leach away damaging salts that can accumulate near roots. (See illustration on the next page.) Wetting the surrounding area allows roots to grow into adjoining soil, providing an extensive root system, which produces a healthier plant. As the tree or shrub grows, increase the number of emitters and enlarge the circle, or add a second circle.

Living in the arid west, soluble salts are common in our soils. When drip systems are installed, salt accumulates where evaporation and drying occurs–at the perimeter of wetted areas. At high concentrations, these salts can damage the roots of many plants. To protect them and reduce salt build-up, place emitters so the wetted areas overlap. Salts will then build up only beyond the plant roots where they will leach down below the root zone.

Most contractors or landscape designers will run a line of drip tubing along a planted path of trees and punch-in emitters near the rootball of trees, leaving enough room to accommodate tree root growth for at least five years. Spaghetti tubing may be used to run the water back to the rootball for young or newly planted trees or shrubs. However, a loop system works best. This allows for the installation of additional emitters as the plant matures. Misters can also be used in this case.

How do I install my drip irrigation system?

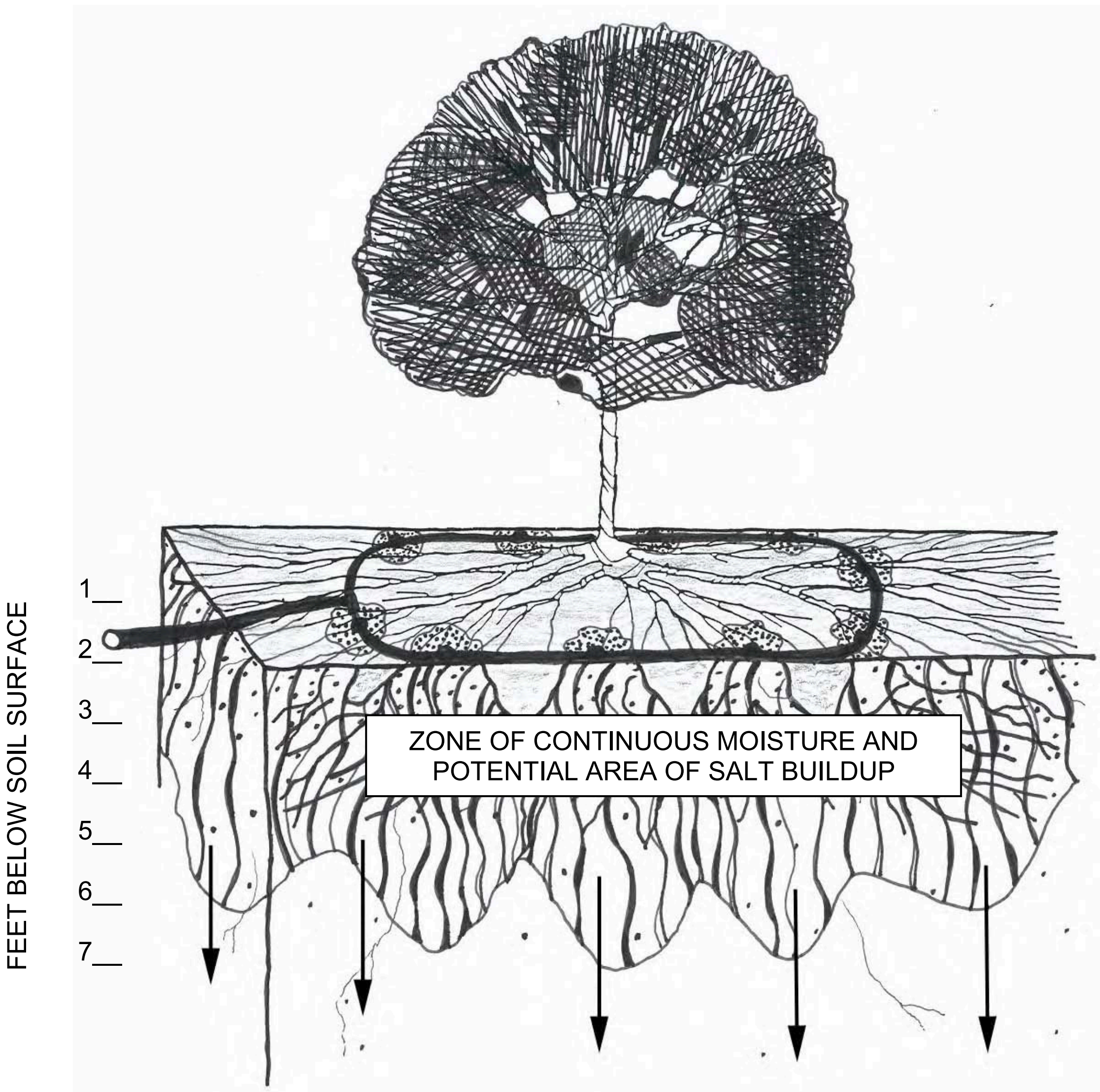
Drip systems range from simple to complicated, depending on landscape needs. The description below is provided as an overview to the process. When you're ready to install your system, check with local irrigation suppliers or landscape maintenance businesses to ensure your system is properly designed for your needs.

First, collect the components you'll need, including tubing, filter, pressure regulator, emitters, sprayers, or porous hose, valves, and PVC pipe. If you have a well, it's especially important to add a back-flow preventer to protect your domestic water supply from possible contamination.

If the drip system will be connected into the main water line, install a shutoff valve between the water line and your drip system to allow you to shut off the irrigation system without affecting your other water uses. Wrap any threaded connections with teflon® tape before attaching them, and hand-tighten any plastic fittings. The arrows on the valves, filter, and pressure regulators must point in the direction of water flow.

Next, connect the tubing to the valve assembly and lay out the main distribution lines. If you follow walls or edges of patios and paths, the lines will be easier to find, and will be protected from disturbance. Once the tubing is in place, lateral or side lines can be attached with tee and elbow fittings. At this point, run water through the tubing to flush out any debris.

Now you're ready to install the drip emitters. Using a hole punch, push to make a hole in the side of the tubing. Insert the emitter, and continue



Salts that may damage plant tissue leach through the soil and away from the root zone if the proper amount of water has been applied.

down the line. A final flush of the line after the emitters are in place will clear out any plastic shavings or other debris. Then, close off the ends of the tubing.

To verify that you've placed enough emitters in the correct locations, run the system for a normal cycle. After waiting a few hours, dig into the soil in several places to check for the spread of water. If coverage is not adequate, add or move emitters.

How much water should I apply to my plants?

Because there are thousands of varieties of landscape plants, it is difficult to predict how much water each plant needs. While it would be convenient to have a chart giving us the amount of water each plant needs over its lifetime, there is none. There are complicated formulas available to calculate water needs based on soil conditions, local climate, and water loss through plant leaves and the soil, also known as evapotranspiration (ET).

For the homeowner, the best way to determine water needs is to monitor soil moisture. A foot-long screwdriver can provide a rough estimate of soil moisture. Push the screwdriver into the soil. If the soil is moist, it will insert easily; in dry soil,it will be difficult to push in the screwdriver. There are a variety of soil probes and moisture sensors (tensiometers) that can provide more accurate estimates of soil moisture. Use the readings to determine if you have watered enough, and when it is time to water again. If the top inch or two of soil is dry, it's time to water. Overwatering is as bad as underwatering—avoid both.

How do I keep my system functioning properly?

Routine maintenance is the key to an effective drip system. Each growing season, when the system is activated, check each emitter to make sure water is dripping as designed. Locate and repair any breaks in the tubing. To avoid frost damage, completely drain the system in the fall prior to regular freezes. Contact your local Cooperative Extension office or your irrigation supplier for the appropriate instructions for your system.

As your plants grow, you'll need to add emitters to deliver water to the spreading root systems. Check on a yearly basis to make sure your system is still providing an adequate supply of water.

Estimating the Number of Emitters

Plant type	Soil type	Number of emitters needed
Low shrubs (1-gallon containers)	Sandy Loam Clay	One 2-gph emitter next to plant One 1-gph emitter next to plant One ½-gph emitter next to plant
Medium to large shrubs (3- to 5-gallon containers)	Sand Loam Clay	Two or three 2-gph emitters placed evenly around plant Two or three 1-gph emitters placed evenly around plant Two or three 1/2-gph emitters placed evenly around plant
Small trees (6- to 8-foot wide canopy or 15 gallon-containers)	Sand Loam Clay	Three to six 1-gph emitters or two or three 2-gph emitters, installed on a loop or on two lines set on opposite sides of trunk Two to four 1-gph emitters, installed as above Two to four ½-gph emitters, installed as above
Larger trees (10- to 15-foot diameter or 24-inch boxes)	Sand Loam Clay	Six to ten 2-gph emitters, installed on a loop or on two lines set on opposite sides of trunk Six to ten 1-gph emitters (or other combination giving the same amount of water), installed as above Six to ten ½-gph emitters, installed as above
Flowerbeds or vegetables	Sand Loam Clay	Several 2-gph emitters spaced about a foot apart in a row Several 1-gph emitters spaced about 1 ½ feet apart in a row Several ½-gph emitters spaced about 1 ½ feet apart in a row